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THE DEVELOPMENT OF UNCUT LIVE BASAL LIMBS AND CROP TREES
AFTER THINNING IN SEEDLING-SAPLING LODGEPOLE PINE

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ABSTRACT

The development of uncut live basal limbs following thinning was studied in four sapling lodgepole pine stands located in North Central Washington. The stands originated from large wildfires in 1970 and were thirteen years old at the time of the study. The uncut live limbs have developed into seedling-sapling trees. Three to six years after thinning, the crop trees had a greater rate of height growth than live limbs upturned from cut stumps. The difference in height between the upturned limbs and the crop trees had increased over the three year period measured. The horizontal rate of growth for the crowns of the crop trees was measured to determine an average crown closure rate for the stands studied.

INTRODUCTION

During the summer of 1970 large wildfires burned thousands of acres on the Okanogan and Wenatchee National Forests. Many of the forested acres burned by those fires had stands of nearly pure lodgepole pine (*Pinus contorta* Dougl.ex Loud.), or lodgepole pine was a major stand component. Many of these stands promptly regenerated naturally to lodgepole pine with minor amounts of other species. Stocking exams taken in these stands six and seven years after the fire showed seedling densities greatly exceeded the level desired to meet management objectives. Managers, faced with these large acreages of overstocked seedling stands, saw the need to start treatment before trees reached a size where fuel treatment needs and costs became a factor, and growth stagnation began to occur.

Stocking level control by hand tool thinning was started in these seedling stands during 1977. The area treated each year since then has increased with most of the thinning accomplished by service contracts. These contracts required all live limbs to be cut with the removal of the excess trees. This has been a difficult requirement for the contractors to meet due to: the nature of limb growth on seedling trees, wood debris from the fire killed stand, high tree densities, and natural obstructions. The result has been numerous contractual disputes. Managers also became concerned about the development of the uncut live limbs in

these thinned stands and what they would mean to future management.

Concern over the contract problems resulting from uncut live limbs caused managers to question the specifications and penalties for the uncut limbs. However, before any contract changes were made, it was felt that the older thinned stands should be studied to determine what has happened to the uncut limbs, and what might be expected in the future. Those needs and concerns were the reasons for this study.

This paper reports the results of the study conducted in four seedling-sapling lodgepole pine stands that resulted from the 1970 fires. These stands had been thinned and were selected because they contained numerous live limbs on stumps of cut trees.

The objectives of the study were: to determine the form and development of uncut live limbs, to determine how the selected crop trees were growing, and to project the most likely crown position that the uncut live limbs will occupy.

STUDY AREA

Stands selected for this study involve three different fire areas on three Ranger Districts and two National Forests. The Forks Fire on the Winthrop District, Okanogan National

Forest, is the site of one of the stands. It is located on rolling topography with a west-northwest aspect at 5,000 feet elevation. A second stand is within that portion of the Mitchell Creek Fire located in Black Canyon Creek on the Twisp District of the Okanogan. The stand is on flat to rolling topography with a north aspect at an elevation of 2,500 feet. The two remaining stands measured for this study are located within a fire area in the Entiat River drainage on the Entiat District of the Wenatchee National Forest. One of these stands is in Preston Creek at an elevation of 3,450 feet on a gentle northwest aspect slope. The other stand is in Brennegan Creek on a flat site at an elevation of 3,200 feet.

The stands selected for study had been thinned from below using hand tools. In all four stands live lower limbs had survived on numerous cut trees following the thinning operation.

Stands in the Forks Fire and in Black Canyon had been thinned three years prior to the study. The two stands on the Entiat District had been thinned six years before the study.

STUDY METHOD

Measurements were made in the fall of 1983 after growth for the year was complete. Fixed plots of 1/250 acre, 14.9 feet

diameter, were used to establish the trees to be measured. Plots were deliberately located to represent the various physical and vegetative conditions in the stands. They were not installed using any grid or random plot location method.

General areas within the stands were located that represented the physical conditions of the site. Plots were then located where numerous upturned limbs from cut stumps were observed. This procedure was required since the occurrence of upturned limbs was not uniform. The plot center was arbitrarily located where the incidence of uncut live basal limbs was high. A total of 24 plots were taken within the four stands.

The intent of the study was to measure the development of uncut live limbs on stumps of trees cut during the thinning operation and the trees left as crop trees. The study did not attempt to determine the density of live limbs as a percentage of cut trees or any other statistically acceptable stocking figures.

DATA COLLECTION

On every plot the following information was collected for potential crop trees.

1. The total height and length of growth for the last three years was measured for each crop tree.
2. The length of horizontal growth for three limbs located between three and five feet from ground level for the past three years was measured and the average for each tree was recorded.
3. The distance between the crowns of the crop trees on and surrounding the plot was measured. An ocular estimate was used to determine the average widest points of the crowns. An average figure for the plot was recorded.

Upturned live limbs growing from identified cut stumps were counted on each plot. The total height of up to five of the limbs was measured along with growth for the past three years. The average of these measurements was recorded for the plot.

Lodgepole pine was the only tree species found and recorded on the plots.

RESULTS AND DISCUSSION

The study has measured four stands during one period of their development in an attempt to determine how live limbs left

uncut during a thinning have developed along with the trees left for the future crop.

Height Growth

The study has found that uncut basal limbs on seedling-sapling lodgepole pine quickly upturn and begin acting as seedling trees. The rate of height growth for these new seedlings is generally less than the crop trees (Table 1).

Table 1 -- Average total height, 3 year growth, and yearly growth rate for 13 year old lodgepole pine crop trees and 3 to 6 year old upturned basal limbs.

Stand	Total Height (Feet)		3 Year Growth (Feet)		Rate/Year (Feet)	
	Upturned		Upturned		Upturned	
	Crop	<u>Limbs</u>	Crop	<u>Limbs</u>	Crop	<u>Limbs</u>
Forks Fire*	7.4	1.4	3.4	0.8	1.1	0.26
Black Canyon*	9.1	3.2	3.9	2.6	1.3	0.87
Preston Cr.+	15.3	5.5	5.2	3.2	1.7	1.06
Brennegan Cr.+	17.6	7.2	6.4	4.2	2.1	1.4

*Thinned 3 growing seasons prior to measurement.

+Thinned 6 growing seasons prior to measurement.

Despite the fact that these basal limb seedlings have a large established root system, they have not shown an accelerated growth rate. Crop tree height growth rates range from 33 percent to 76 percent greater for the four stands, based on data from Table 1.

The thinnings in these four stands were accomplished during the period when seedling lodgepole pine begins to experience accelerated height growth. Perry 1977, in a study of lodgepole pine regeneration in clearcuts, found that height growth increased significantly after the seedling reached a height of one meter (3.28 ft.). This study has also shown this increase in the rate of height growth. For the Forks and Black Canyon stands, height growth for the first ten years averaged .5 feet per year. Growth was calculated using nine years to determine the rate per year based on the assumption that little growth occurred during the year of germination. The trees in the same stands have grown at an average yearly rate of 1.2 feet during the period from 10 to 13 years. Some workers have shown thinning to have a significant effect on height growth in seedling-sapling lodgepole pine stands on low and intermediate quality sites (Johnstone, 1981). This study did not try to determine how much of the height growth increase resulted from the thinning effect or the growth patterns of lodgepole pine.

The measurements and observations for these stands show that the uncut basal limbs initially perform much like seedling

trees at a time when the crop trees are increasing their rate of height growth. At the time of thinning, the crop trees were also given a large advantage in height over the basal limbs. That height advantage has increased over the three year period measured in this study. The height differential between crop trees and upturned limbs at the start of the three year period and the end has increased 24 to 29 percent for three stands and 76 percent for the Forks stand. The height development for crop trees and basal limbs is illustrated in Figure 1.

Lodgepole pine is classed as a very shade intolerant species (Burns, 1983). Long term observations of stand development show that trees losing their place in the upper crown levels seldom recover it (Smith, 1962). These considerations, combined with the results of this study, indicate that the upturned basal limbs will remain overtopped to intermediate trees in these stands.

CROP TREE CROWN DEVELOPMENT

The development of the crown, principally the horizontal expansion, was measured to determine the crown closure rate of the crop trees. The determination of this rate would give an estimate of when the suppressive effect of crop tree shading would influence the development of the upturned basal

Figure 1 Height at Start and End of 3 Year Period
13 Year Old Thinned Lodgepole Pine

Crop Trees:

Start 3 Year Period -



3 Year Period -



Uncut Live Limbs:

Start 3 Year Period -



3 Year Period -



Height - Feet

Forks
Burn

Black
Canyon

Preston
Creek

Brennegan
Creek

limbs. The closure rate could also figure into the determination of the desired stocking level.

The horizontal growth of limbs for the stands studied had a range of from 0.57 to 0.48 feet per year and a mean of 0.52 feet for all crop trees. This gives an average crown closure rate of 1.04 feet per year.

Based on the plots taken, crop tree density is estimated to range between 416 to 857 trees per acre. The average square spacing for those densities in the four stands ranges from 7 to 10 feet.

The average spacing between the crowns of crop trees ranged from 3.6 feet for the Black Canyon stand, which has the highest crop tree density, to 7 feet in the Forks stand that has a medium density but the smallest trees. Projecting average measured crown closure rates, the lower half of the crowns in these stands should begin physical contact at four years for Black Canyon and up to seven years for the Forks stand.

Personal observations made in immature lodgepole pine stands and work done to develop site indexes for lodgepole pine in the intermountain region indicate that crown diameters of 10 feet and greater can be expected to develop on the dominant and codominant trees (Alexander, Tackle, Dahms, 1967). This

indicates that crown closure can be expected in all of the stands studied.

CONCLUSIONS

1. The measurements and observations made in this study show that uncut live limbs on stumps of cut lodgepole pine will upturn and begin acting as seedling trees. However, their rate of height growth during the first two to three years is less than might be expected, given the large established root system. Initial growth is similar to that of a three to five year old seedling tree.
2. Crop trees in these stands are increasing in height at a greater rate than the upturned basal limbs. They are into a period of rapid growth that seems to be a combination of their growth patterns and the effect of the thinning. The indications are that the differential in height will continue to increase.
3. The study indicates that, for the stands measured, crop tree crowns are presently closing at an average rate of one foot per year. Crown diameters of 10 feet and greater can be expected which indicates that crown closure will occur in the stands studied.

4. The results of the study suggest that the majority of trees developing from uncut limbs will not regain a place in the upper crown levels to directly compete with the crop trees. The study used conditions found in four stands to draw the conclusions. Due to the period of development measured, and the lack of controls of a designed study, the future effect of the live limbs and what density is acceptable was not determined.

RECOMMENDATIONS

1. Contracts for thinning seedling-sapling stands of lodgepole pine should continue to require that all live limbs be cut during removal of excess trees. However, since excess trees and uncut live limbs can be expected to perform and affect the stand differently, uncut live limbs could be treated separately in the contract. Further study is required to determine acceptable levels for live limbs but, thinning studies in seedling lodgepole pine might be used to set interim limits. Johnstone 1981, suggested that the desirable range of crop tree stocking after thinning in seedling lodgepole pine ranges between 800 to 1,000 trees per acre. Most prescriptions for thinning in these types of stands in North Central Washington have called for crop tree densities of 350 to 450 trees per acre. It is suggested

that the total number of crop and uncut live limbs not exceed the 800 to 1,000 per acre figure, with a cut stump having one or more live limbs count as one live limb. Penalties would be assessed when contractors exceeded the total figure.

2. Thinnings in seedlings-sapling lodgepole pine stands should not be carried out until the average potential crop trees have reached a height of four to five feet. This is to take full advantage of the increasing height growth rate of the trees and the height advantage gained over possible uncut green limbs.
3. Observations made, but not studied, in adjoining stands thinned at age thirteen, the year of this study, showed a very low incidence of live basal limbs on cut stumps. There was evidence of lower limbs that had recently died indicating natural suppression of the lowest branches was taking place. The indication is that waiting three to four additional years past the minimum recommended crop tree height of four to five feet and/or until the stand is seven to ten feet tall may significantly reduce the problem of uncut live limbs.
4. Further study of these stands should be conducted in three to five years to determine the trends in growth and development. Additional plot information would be taken at that time so that growth projection models

could be used to predict future yields with and without
the understory live limbs.

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